Facilitating Restoration of the Hawthorne House for Owner-Occupied Affordable Housing

FY 2012 CPA Proposal – Submitted on 10 December 2010

After extensive negotiations, the town acquired the Hawthorne property this past summer, including a 200+ year-old house and associated outbuildings with frontage at 235 East Pleasant Street. The purchase was recommended by the CPA Committee and received overwhelming support at town meeting, which appropriated $500,000 to buy the Hawthorne property for recreation, conservation, and affordable housing.

The town had initially hoped that the Hawthorne family would be willing to sell the house and outbuildings separately to someone other than the town. The town's negotiators were not able to accomplish this goal. So the town now owns historic structures on a portion of a property it would have preferred not to own, combined with a mandate to produce affordable housing on a site very much constrained by wetlands and the laws protecting them.

The greenest way to produce affordable housing is to restore the existing structure. Restoration is also the most effective way to surmount the wetlands issues on the site. In terms of cost-effectiveness, restoration is on par with demolition and building anew, in great part because of the asbestos and potential lead-paint issues that would affect each process.

This proposal seeks funding to address foundation and sill issues, and potential lead paint problems. It is submitted by this CPA Committee member in the same spirit that prompted Committee chair Peter Jessup's Rolling Green proposal, which was recommended by the CPA Committee and subsequently approved by the Fall 2010 Special Town Meeting.

This proposal addresses the issue of the work to be done, rather than who would do it. Town spokespeople have made it clear that an entity other than the town would ultimately produce and sell the affordable housing to (a) qualified buyer(s) in accordance with a process similar to that for Habitat's West Pomeroy Lane house. Funding these activities, particularly any potential lead paint abatement that might be necessitated by partial interior and exterior demolition resulting from an architect's interaction with the building commissioner, seems therefore quite separable from who might direct their ultimate accomplishment.

Request for Funding – $81,000

$40,000 for foundation and sill work. A placeholder amount pending study.

$40,000 for potential lead paint work. A placeholder amount pending study.

$1,200 for a dendrology dating study (see accompanying material) of the house that might help in grant applications, fundraising, attracting the interest of a non-profit affordable housing restorer, etc.

1. **Project Feasibility.** The two primary issues for which funding is being sought are concerns which are likely to deter interest in restoration by non-profit groups. The cost estimate total is in the ballpark of the cost to the town for demolishing the existing house to facilitate building anew. Both issues involve known processes with predictable costs that are refineable once more thorough study is done.

2. **Urgency.** The Hawthorne House has only ten+ months left on an Historical Commission demolition delay. If money is made available for issues that are most likely to deter non-profit restoration, it will enhance the likelihood that the town will choose restoration as a course of action, one which has many other positive benefits.

3. **Population(s) to be served by the project.** The low-income famil(y/ies) who will reside in the house would benefit from the existing structure's very favorable solar accessible siting and a layout which directs activities away from a busy nearby street – neither of which could be replicated were the existing structure to be demolished.

4. **Acquisition or preservation of threatened resources.** The town owns the house, but its application for a demolition permit seems to be a clear indication of intent should funds not become available to address these issues . Making these funds available would help tip the scale toward preservation, a course of action favored by the CPA Act.

5. **Possibility of multiple sources of funding.** If the house is preserved and restored as a one- or two-unit residence for low-income families, there is a good likelihood of both volunteer labor and funding for that purpose from the larger neighborhood with ties to the property because of Glen Hawthorne's farmstand, concerns about streetscape and historic preservation, etc. Restoration of the house could qualify for historic preservation and other grants.

6. **Complete description of project addressing cost; documentation relating to projected timeline for the initiation and completion of project, and any expectations for additional funding in future years.** Project is well described by material above. The timeline for accomplishment of the proposed activities depends entirely on whether the town proposes to have the work done on its own behalf or whether it transfers the house to a non-profit with a guarantee that funding for these purposes is available from the monies proposed to be appropriated. Need for additional funding is dependent upon decisions re number of units, final layout, code compliance requirements, etc., which are presently unknown.

7. **Funding available.** If responsibility is assigned to both affordable housing and historic preservation categories, there would be more than enough CPA money available.

Sincerely,

Vincent O'Connor

Vincent O'Connor, at-large CPA Committee member, Precinct #1 Town Meeting member
175 Summer Street #12
413/549-0810

Historic Deerfield, Inc.
Deerfield, Massachusetts

Dendrochronology Study Proposal- 235 East Pleasant St, Amherst, MA

The dendrochronology study will consist of a site visit by William Flynt to obtain samples, sample preparation (mounting, sanding, species confirmation, ring counts), microscopic measuring, data analysis, and a written report.

In undertaking a dendrochronology study of any timber frame structure, a number of parameters need to be met in order for the study to have a decent chance of success. It should be noted, however, that even if all the criteria are met, the possibility exists that the results will be inconclusive.

The following parameters must be taken into consideration;

1. 10-12 samples need to be obtained from each distinct period of construction that is being investigated. It is my understanding that only the main portion of the house is to be dated. If other portions are determined to be distinct builds and it is decided by the owner to sample them, then the sample count and thus the cost will be adjusted.
2. Timber species must be Oak, Pitch pine, Hemlock, or possibly Chestnut and White pine as these species are the only ones for which there currently exist regional dated master chronologies / site chronologies.
3. Waney, or bark edge, timbers of sufficient numbers must be accessible for coring.
4. Timbers must have a minimum of 55-60 growth rings to be deemed potentially usable.
5. While not mandatory, it is best if the study has access to any current research pertaining to the structure/site. Floor/framing plans are also useful and need to be made available, if they exist, for plotting sample locations.

Fees

The cost of the complete study is based on obtaining 10-12 samples from each portion of the structure wishing to be dated. The minimum cost of a study is $750.Should it be determined that none of the timbers are suitable for sampling, the fee for the site visit will be figured at a daily rate of $350, plus mileage.

Historic Deerfield

Opening Doorways To The Past.

<u>William Flynt – Historic Deerfield, Inc.</u>

Dendrochronology Studies- Select Client list

- Old Sturbridge Village, Sturbridge, MA
- David E. Lanoue, Inc, Great Barrington, MA
- Mesick, Cohen, Wilson, Baker Architects, Albany, NY
- Newport Collaborative Architects, Newport, RI
- Trustees of Reservations, Stockbridge, MA
- Michael White Contractors, Mill River, MA
- Restoration and Traditional Building Company, Greensboro Bend, VT
- University of Massachusetts Contract Archeology, Amherst, MA
- Cape Ann Museum, White-Ellery house and barn, Gloucester, MA
- Numerous private clients (MA, CT, NY)- names on request

WILLIAM A. FLYNT

EDUCATION

2002 – Dendrochronology tutorial with Paul Krusic, dendrochronologist, Lamont-Doherty Tree-Ring Laboratory, Palisades, NY
1982 - "Architectural Conservation Short Course" Summer Program at West Dean College, Chichester, England.
1977-79- University of Vermont, Burlington, Vt., MS in Historic Preservation
1971-75- Williams College, Williamstown, Ma., BA in Geology. Secondary interest in Architectural History.

PROFESSIONAL EMPLOYMENT

2005- Feb-May- Acting Superintendent of Properties Maintenance, Historic Deerfield
2004- May- October- Acting Superintendent Properties Maintenance, Historic Deerfield
2003- Jan.– Mar.- Interim Director, Historic Deerfield, Inc., Deerfield, Ma.
1979- Present- Architectural Conservator, Historic Deerfield Inc., Deerfield, Ma.
1978-79- Preservation Consultant for First Church of Christ, Wethersfield, Ct.
1978- Summer Intern, The Preservation Partnership, Natick, Ma.
1976-77- Carpenter, Babcock Barns, Hancock, Ma.

APPOINTMENTS

1987-1990-Board member, Historic Massachusetts, Boston, Ma.
1990- 2000-Board member, Porter-Phelps-Huntington House, Hadley, Ma.
1999-2001 -Gov. Samuel Huntington Trust House Advisory Board, Scotland CT.
2000- 2002-Portland Museum of Art, McLelland House Advisory Board, Portland, ME.
2001-Present-Board member, New England Chapter of the Vernacular Architecture Forum

LECTURES

-"Tree-Ring Dating Historic Structures in the Northeast" Traditional Building Conference, Boston, March, 2007
- "Dendrochronology for Timber Framing Dating in the Northeast" TTRAG annual symposium, Lenox, MA, May 2006.
-"The Timbers are Talking, Developing Chronologies and Dating Historic Structures in the Connecticut River Valley" Dendrochronology in the Northeast Symposium, Deerfield, MA. May 2005. (Co-organizer of the symposium)
-"The Timbers are Talking; Recent Dendrochronology Work in the Connecticut River Valley" Historic Deerfield, Fall 2003, Longmeadow Historical Society, Summer 2004

-"Henry & Helen's Excellent Adventure: The Creation and Refinement of Historic Deerfield" Colonial Williamsburg Forum 2/97, Greenwich Historical Society 5/97, Historic Deerfield 11/97, Decorative Arts Trust 10/98, Hist. Dfld. 4/02
-"Restoring a Building as a Primary Artifact for Interpretation" Vt. 3rd. Annual Historic Preservation Conference, St. Johnsbury, VT 6/97
-"A Selection of Conn. River Valley Interiors retaining their Original Finishes" Eastfield Village, NY. 6/96
-"The Shrinking Preservation Budget; What not to do First: Buildings" 1995 NEMA Annual Meeting 11/95
- Participant, Architectural Fragments Collections Management Symposium, Colonial Williamsburg 9/95
-"The Hinsdale and Anna Williams House Restoration: Opening a Restoration Project to the Public" 1994 NEMA Annual Meeting, Portland 11/94
-"Returned to Glory: A Review of Restoration Research, Procedures & Techniques employed at the Hinsdale and Anna Williams House" SAH Conn. River Valley Tour, Deerfield 6/92, Colonial Society, Boston 11/93, Deerfield 2/94
-"Restoration Reality: Let the building Speak" Restoration 93, Boston 12/93
-"Restoration Practice: Then & Now" Eastfield Village, NY 8/93
-"Recognizing, Reading and Restoring Old Houses" Four session course offered at Historic Deerfield 3/93
-"Consistently Inconsistent: Interpreting Evidence during the Ebenezer Hinsdale Williams House Restoration" Old Sturbridge Village 4/91

PUBLICATIONS

"The Timbers are Talking" *Historic Deerfield Magazine* Winter 2004/5 Vol. 5, No.1. pp 13-18.
"God Gave Me Hands That Could Draw and a Brain That Just Knew Old Things", *Historic Deerfield Magazine*, 2002, Vol 2, No. 1, pp 17-22
"The Design of a Display Rack for Historic Textiles" *Technology and Conservation,* March, 1988
"Gutter Restoration at Historic Deerfield" The *Old House journal,* April 1987
"Exterior Architectural Embellishment" *The Magazine Antiques,* March 1985

RESEARCH/RESTORATION PROJECTS

1978-79 -- 1764 First Church of Christ Steeple Restoration, Wethersfield, Ct.
1981-1993 -- 1816 Williams House Research/Restoration, Deerfield
1986-87 -- 1725-1850 Wells-Thorn House Research/Reinterpretation, Deerfield
1991-Present -- 1848 Moors House Research/Restoration, Deerfield
1998-01 -- Sheldon-Hawks House Re-restoration /Reinterpretation, Deerfield
2005-present—Barnard Tavern Re-restoration/Reinterpretation, Deerfield
2001- Present – Dendrochronology sampling /analysis of New England architecture with an emphasis on the Connecticut River Valley.

A Dendrochronological Study of Select Timbers and Boards from the David Ruggles Center, 225 Nonotuck Street, Florence, Massachusetts

William A. Flynt
Architectural Conservator
Historic Deerfield, Inc.
Deerfield, MA

October, 2010

A Dendrochronological Study of Select Framing Members from the David Ruggles Center, Florence, MA

Introduction
On March 31st, 2010, a selection of hemlock boards and chestnut timbers in the David Ruggles Center at 225 Nonotuck Street in Florence, MA were sampled by William Flynt for the purposes of conducting a future dendrochronological study. The samples were prepped and analyzed at Historic Deerfield by William Flynt, Architectural Conservator.

Background
Dendrochronology, or the study of tree ring growth patterns to date the age of archeological timbers, was initially developed in the 1920's by Andrew E. Douglass using long-lived Ponderosa pines in the Southwest United States. An astronomer by training, Douglass was interested in historical sun spot activity and its relationship to earth's climate. He surmised that by looking at yearly growth ring sequences in long-lived trees growing in an arid environment where moisture is key, he might be able to ascertain yearly variations in climate attributable to sunspot activity. (Baillie, 1982). To push the tree ring database back past the age of living trees, samples were taken from roof poles in Pueblo ruins which turned out to eventually overlap the living tree data. Besides fulfilling his research needs, this work revealed the feasibility of dating archeological structures.

In the 1980's the advent of computer programs to collate the data and compile master chronologies enabled unknown samples to be compared to known masters with a high degree of accuracy. Work in Eastern Massachusetts focusing on Oak (Krusic and Cook 2001, Miles, Worthington and Grady 2002, 2003, 2005) and in the Connecticut River valley initially concentrating on Pitch pine (Flynt 2004) and expanding into oak, chestnut, hemlock, and white pine has revealed the suitability of using dendrochronology as a mainstream research tool for analyzing and establishing construction timber felling dates in the Northeast, a region heretofore considered too variable climatically to provide reliable results.

To aid with this specific study, a variety of dated master chronologies are available including a small Deerfield area chestnut master, a Connecticut River Valley of Massachusetts chestnut master, as well as a Connecticut River Valley of Massachusetts hemlock master.

Procedures
In procuring samples suitable for dendrochronology research, the analyst must be on the lookout for timbers, framing, and boards that exhibit several parameters. First, a bark, or waney, edge must be present if one wishes to establish with certainty the last year of growth. Second, there needs to be a sufficient number of rings in a sample to span several distinctive climactic variations that register as patterns of wide and narrow rings. Ideally, having 100 years of growth is best, but more often than not, samples will range from 60 to 100+ years. While it is feasible to get dates on young samples, spurious results are possible and thus must be reviewed carefully both with longer-lived samples from the same structure as well as with what documentary and stylistic research uncovers. Third,

enough samples need to be obtained (10-15 per building episode is usually reasonable) to allow for comparison and the fact that often some will not date for one reason or another. It is also critical that an assessment be made of the building frame to ascertain that the members from which samples are extracted were not reused or inserted at a later date. Fourth, all samples must be labeled and entered into a log book that notes the position of each sampled timber within the structure, its species, whether or not it has wane, and any other information pertinent to the sample. In labeling the samples, the following code was employed; FDR (Florence, David Ruggles) with the numbers that follow simply referring to the sequence in which the samples were taken.

Samples were taken using a custom coring bit, chucked into a ½" Bosch battery-powered drill that creates a 9/16" hole out of which is obtained a 3/8" core. Core samples were glued into custom wood mounts and sanded using successively finer grit paper (60-600 grit) both on a bench top belt sander and by hand sanding to create a mirror-smooth finish. In addition, the hemlock samples were obtained by cutting 1 inch strips off removed sub-floorboards that exhibited waney edges. These too, were sanded as noted above. All samples were then viewed under a Unitron ZST 7.5-45X binocular microscope fitted with cross hairs in one eyepiece to ascertain and mark the number of rings per sample. This was followed by a visual review of all samples from the structures to determine if site-specific growth patterns could be picked out. Each sample was then placed under the microscope on a Velmex Acu-Rite Encoder sliding stage calibrated to read to the nearest micron (.001mm). Measuring begins at the outer, or last year of growth ring (LYOM), established as 1000, and proceeds to the center of the sample or first year of measure (FYOM). At the junction of each growth ring, the analyst registers the interface electronically which sends the measurement to the computer via a Quick-Chek Digital Readout. In all of the work in this study, the measuring program PJK10v10e was used to compile each structure's raw data files. The program transforms the ring widths into a series of indices that relate each ring's growth to its neighbors, thus standardizing the climate-related influences on a year to year basis (Krusic 2001). Thus trees from a similar location but growing at different rates should exhibit similar indices. With the raw data in hand, using the program COFECHA, samples from each site can be compared with each other to determine if all were cut more or less at the same time or within the span of several years or more. The samples are also compared against one or more dated regional master chronologies of the same species to determine the exact year or years when the samples in question were felled. As strong samples are uncovered, these are added to a fledgling site master and the raw data is again run against the site master to see if additional samples align.

With COFECHA samples are broken down into ring groups of 50 years which are compared to various dated masters. The 50-year groupings in an individual sample are lagged a certain number of years (5 years is used with the short-lived chestnut samples in this study while a 25 year lag is used with the longer growing hemlock samples) to provide an overlap of data within the groupings. The results are displayed in a series of columns with the "best fit" being in column #1, the next "best fit" in column #2 and so on out 10 columns. The "add" number is the number to be added to the last year of growth (1000) to provide the year date of felling, while the "corr" number relates to how well the "add" meshes with the master. .3281 is considered the threshold of significance. High correlation values (preferably over .40) accompanying consistent "add" numbers in the first column usually reveal reliable results. In the example below, consistent "add" numbers with strong correlations appearing in the first column for samples DLBH-07 and 08 reveal each samples true date of felling (1784 and 1782 respectively). Sample DLBH-09 does not show strong correlation with any particular date.

SERIES	COUNTED SEGMENT	ADD CORR # 1	ADD CORR # 2	ADD CORR # 3	ADD CORR # 4	ADD CORR # 5	ADD CORR # 6	ADD CORR # 7	ADD CORR # 8	ADD CORR # 9	ADD CORR #10
DLBH-07	937- 986	784 .51	712 .47	729 .37	713 .37	847 .33	846 .31	728 .30	813 .29	800 .29	763 .28
DLBH-07	947- 996	784 .54	712 .45	760 .33	816 .31	729 .31	800 .29	713 .29	671 .29	847 .26	808 .25
DLBH-07	951-1000	784 .41	760 .35	712 .35	661 .31	787 .30	800 .29	774 .29	729 .27	808 .26	832 .25
DLBH-08	929- 978	782 .44	746 .42	793 .33	760 .32	705 .32	840 .31	858 .30	689 .30	824 .28	685 .26
DLBH-08	939- 988	782 .61	746 .37	689 .34	840 .30	725 .29	708 .27	723 .27	806 .27	684 .25	724 .25
DLBH-08	949- 998	782 .69	669 .47	840 .41	722 .32	806 .28	708 .27	700 .26	683 .25	723 .25	720 .24
DLBH-08	951-1000	782 .69	669 .38	840 .38	722 .34	757 .29	700 .28	730 .25	659 .24	838 .23	723 .23
DLBH-09	932- 981	713 .52	785 .35	848 .35	744 .35	729 .32	863 .31	846 .28	849 .26	693 .26	714 .25
DLBH-09	942- 991	846 .38	713 .36	785 .33	848 .33	729 .29	727 .29	790 .29	693 .28	761 .28	705 .27
DLBH-09	951-1000	799 .43	783 .39	731 .30	689 .30	808 .29	767 .27	756 .26	790 .25	814 .24	846 .24

Results (See Figure 1 for sample set summary)

Chestnut

All of the six samples taken from framing timbers turned out to be fairly short-lived chestnut which just barely had enough rings to provide meaningful results. The group was first compared against the longest-growing sample in the group (FDR-05) which allowed for an undated site master to be developed (Chart 1). From the data it is clear that the majority of these samples were felled in the same year (some came down before the growing season ended while others were felled after the growing season stopped, see Figure 1). When the sample group was compared to the dated Deerfield Chestnut Master, sample FDR-05 showed good correlation with 1846 for most of its growth as did a portion of FDR-04. As well, all but the last three years of growth in sample FDR-03 align convincingly with 1847. In comparing the results of these three samples with Chart 1 results reveals good correlation which then allows for the remaining undated samples depicted in Chart 2 to be given dates based on the Chart 1 data. Chart 3, Part 2, depicts the Ruggles Center chestnut site master inter-sample correlation while Part 8 reveals how the group as a whole aligns with this master. While sample FDR-06 shows promise to want to date to 1845, and most likely does, its weak correlations of less than .3281 prevents it from being added to the chestnut site master.

Hemlock

The four hemlock samples all came from subfloor boards that were being scrapped and thus samples were simply cut through the waney portions with a saw. When the group of samples was compared to the longest growing sample (FDR-08), the other three samples all aligned strongly with this sample (Chart 4). Note that sample FDR-10 had a partial last growth ring which wasn't measured, so in reality it was felled the same year as the other samples, only during the summer growing season rather than after the growing season stopped. When these samples were compared to the Connecticut River Valley of Massachusetts Hemlock master all samples convincingly aligned with 1845 (again, remember that FDR-10 has an unmeasured partial last ring). Chart 6 reveals how well the Ruggles Hemlock samples align with the Ruggles center hemlock site master with Part 2 depicting the strong correlation between the samples (with such high correlation coefficients it is suspected that the boards may have all come from the same tree) while Part 8 reveals the results of running the samples against the dated hemlock site master.

Conclusion

It is clear from the data that the house at 225 Nonotuck Street was constructed no earlier than 1848 with lumber felled in the latter half of 1847. While framing was likely carried out when the timbers were still green, the board stock had been dried for at least a year before it was used, a logical scenario as one would want dried lumber for interior work, even subflooring. To further corroborate the date of construction it would be wise to inspect the tax records for the lot, if they exist, for the years 1846 - 1850 as a distinct rise in the valuation should be detected when the house was erected.

Acknowledgments

The author would like to thank Kris Thomson for his interest in dendrochronology and the importance of using it to firmly establish the construction dates of the regions' historic architecture.

Sources:

Baillie, M.G.L. 1982 *Tree-Ring Dating and Archeology.* Croom Helm, London and Canberra.

Flynt, W. 2004. *A Dendrochronological Study of a Select Group of Deerfield, Massachusetts Buildings.* Deerfield, MA.

Krusic, P.J. and Cook E.R. 2001. *The Development of Standard Tree-Ring Chronologies for Dating Historic Structures in Eastern Massachusetts, Phase I.* Great Bay Tree-Ring Lab and The Society for the Preservation of New England Antiquities, Durham, NH and Boston.

Miles,D.W.H., Worthington, M.J. and Grady,A.A. 2002. *Development of Standard Tree-Ring Chronologies for Dating Historic Structures in Eastern Massachusetts, Phase II.* The Society for the Preservation of New England Antiquities and Oxford Dendrochronological Lab. Boston and Oxfordshire.

Miles,D.W.H., Worthington,M.J. and Grady, A.A. 2003 *Development of Standard Tree-Ring Chronologies for Dating Historic Structures in Eastern Massachusetts, Phase III.* The Society for the Preservation of New England Antiquities and Oxford Dendrochronological Lab, Boston and Oxfordshire.

Miles,D.W.H.,Worthington, M.J. and Grady,A.A. 2005 *Development of Standard Tree-Ring Chronologies for Dating Historic Structures in Eastern Massachusetts, Phase IV.* The Society for the Preservation of New England Antiquities and Oxford Dendrochronology Laboratory, Boston and Oxfordshire.

FIGURE 1

SAMPLE	AGE	FYOM	LYOM	WANE	SPECIES	LOCATION
FDR-01	57	1791	1847	Y	CADN	WEST SILL
FDR-02	53	1795	1847	Y	CADN	NORTH SILL
FDR-03	43	1805	1847	Y	CADN	EAST SILL
FDR-04	62	1785	1846	Y*	CADN	TIMBER UNDER NW ROOM SOUTH WALL
FDR-05	67	1780	1846	Y*	CADN	TIMBER UNDER SW ROOM EAST WALL
FDR-06	55	946	1000	Y	CADN	ELL,1ST JOIST FROM WEST SILL
FDR-07	125	1721	1845	Y	TCSA	NW ROOM SUBFLOORING
FDR-08	145	1701	1845	Y	TCSA	NW ROOM SUBFLOORING
FDR-09	135	1711	1845	Y	TCSA	NW ROOM SUBFLOORING
FDR-10	80	1765	1844	Y*	TCSA	SW ROOM SUBFLOORING

CADN = CHESTNUT
TCSA = HEMLOCK
FYOM = FIRST YEAR OF MEASURE
LYOM = LAST YEAR OF MEASURE
* = LAST RING PARTIAL,NOT MEASURED.TREE FELLED IN THE FOLLOWING SUMMER.ADD 1 TO LYOM.

CHART 1

PART 2: CORRELATIONS WITH MASTER SERIES OF ALL SEGMENTS AS DATED AND MEASURED Tucson-Mendoza-Hamburg-Lamont ProgLib

32-YEAR CUBIC SPLINE FILTER; CORRELATIONS OF 50-YEAR SEGMENTS LAGGED 5 YEARS

FLAGS: _A = CORRELATION UNDER 0.3281; _B = CORRELATION HIGHER AT OTHER POSITION

0SEQ	SERIES	INTERVAL	930 979	935 984	940 989	945 994	950 999	955 1004	960 1009	965 1014	970 1019	975 1024	980 1029	985 1034	990 1039	995 1044	1000 1049	1005 1054	1010 1059	1015 1064	1020 1069	1025 1074	FLAGS/ TOTAL
1	FDR-01	945-1001	=	=	=	.44	.42	.40	=	=	=	=	=	=	=	=							
+																							0/ 3
2	FDR-02	949-1001	=	=	=	.52	.53	.51	=	=	=	=	=	=	=	=							
+																							0/ 3
3	FDR-04	939-1000	=	.44	.44	.55	.56	.57	=	=	=	=	=	=	=	=							
+																							0/ 5
4	FDR-05	939-1000	=	.51	.50	.60	.59	.59	=	=	=	=	=	=	=	=							
+																							0/ 5

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES Tucson-Mendoza-Hamburg-Lamont ProgLib

FDR CHESTNUT VS FDR-01,02,04,05 UNDATED
50-YEAR SEGMENTS LAGGED 5 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
FDR-01	944- 993	1 .68	-2 .28	2 .26	4 .20	5 .15	-1 .07	6 .05	-5 .04	3 .02	-4 .00	7-.01
FDR-01	949- 998	1 .67	-2 .28	2 .26	-14 .19	3 .06	-13 .05	-5 .03	-1 .00	-4-.01	-8-.03	-11-.07
FDR-01	951-1000	1 .66	-17 .30	-2 .26	-16 .18	-14 .13	-8 .07	-4 .05	-1 .03	-13 .02	-5-.05	-11-.06
FDR-02	948- 997	1 .70	-14 .29	4 .11	-2 .10	2 .10	0 .08	-5 .05	-3 .02	-7-.01	-10-.02	3-.03
FDR-02	951-1000	1 .70	-14 .25	-17 .17	0 .11	-2 .09	-13 .01	-10 .00	-3-.01	-15-.01	-4-.04	-5-.05
FDR-03	958-1000	1 .60	-2 .38	-22 .22	-21 .22	-18 .18	-16 .15	-13 .13	-1 .09	0 .08	-20 .08	-23 .08
FDR-04	939- 988	0 .71	3 .26	-3 .21	4 .18	6 .13	-1 .11	1 .08	2 .07	7 .06	9-.07	-4-.08
FDR-04	944- 993	0 .72	-3 .28	3 .26	4 .17	7 .15	-1 .07	6 .07	-9-.02	-4-.02	2-.04	1-.06
FDR-04	949- 998	0 .75	3 .24	-3 .19	-1 .12	-15 .05	-2 .05	-14 .04	-12 .02	2 .01	-4 .00	1-.06
FDR-04	951-1000	0 .76	-3 .24	-16 .19	-1 .08	-2 .07	-14 .05	-15 .04	-17 .02	-12 .00	-4-.04	1-.07
FDR-05	934- 983	0 .85	18 .24	3 .23	15 .10	9 .06	16 .06	14 .03	17 .03	4-.01	5-.03	12-.04
FDR-05	939- 988	0 .84	3 .22	-4 .20	-1 .16	-2 .10	-5 .07	-3 .05	9 .04	2-.04	12-.04	5-.07
FDR-05	944- 993	0 .85	-4 .21	3 .17	-9 .15	-3 .13	-1 .08	-2 .02	2 .00	-6-.01	-5-.04	-7-.04
FDR-05	949- 998	0 .83	3 .17	-4 .14	-1 .14	-3 .11	-9 .07	-15 .03	-7 .02	-2 .00	2-.01	-5-.04
FDR-05	951-1000	0 .83	-3 .14	-4 .13	-1 .12	-9 .07	-16 .06	-7 .06	-15 .03	-2 .01	-5-.01	1-.06
FDR-06	946- 995	-1 .27	5 .17	1 .14	-7 .10	-10 .08	-6 .06	6 .05	3 .04	-9 .04	-2-.01	0-.02
FDR-06	951-1000	-1 .28	1 .21	-15 .10	-6 .09	-4 .07	-2 .04	-17 .03	-7 .00	0 .00	-16-.02	-9-.03

CHART 2

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES Tucson-Mendoza-Hamburg-Lamont ProgLib

FDR-C VS DFLD CHESTNUT MASTER
50-YEAR SEGMENTS LAGGED 5 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
FDR-01	944- 993	832 .34	848 .29	797 .29	798 .29	847 .28	815 .28	794 .26	818 .21	850 .21	835 .20	809 .20
FDR-01	949- 998	832 .29	797 .26	798 .26	794 .26	815 .23	835 .23	818 .22	809 .21	812 .21	814 .20	800 .18
FDR-01	951-1000	797 .33	832 .30	818 .23	815 .23	794 .23	814 .22	772 .22	809 .21	798 .18	835 .18	812 .18
FDR-02	948- 997	847 .60	809 .34	832 .28	796 .23	838 .22	817 .19	798 .18	807 .17	841 .17	827 .16	793 .16
FDR-02	951-1000	809 .28	832 .24	827 .21	772 .21	796 .20	775 .20	777 .19	817 .19	838 .17	818 .17	807 .16
FDR-03	958-1000	844 .26	814 .26	827 .26	787 .25	830 .24	774 .22	806 .20	812 .19	800 .18	778 .18	777 .17
FDR-04	939- 988	800 .27	846 .27	836 .24	802 .24	796 .23	792 .20	826 .18	837 .17	832 .16	820 .16	805 .15
FDR-04	944- 993	846 .32	796 .29	799 .25	843 .22	837 .19	800 .18	840 .17	826 .16	802 .16	836 .15	805 .14
FDR-04	949- 998	846 .47	799 .29	826 .28	836 .24	796 .24	786 .18	789 .18	802 .17	813 .16	792 .15	823 .15
FDR-04	951-1000	826 .26	796 .24	799 .24	786 .21	773 .20	792 .19	836 .19	789 .18	776 .17	832 .15	813 .15
FDR-05	934- 983	846 .41	814 .33	852 .26	812 .25	817 .22	851 .20	837 .20	794 .19	798 .17	795 .16	849 .16
FDR-05	939- 988	846 .43	814 .36	837 .19	851 .19	799 .19	817 .18	792 .17	798 .17	834 .16	812 .16	816 .15
FDR-05	944- 993	846 .52	814 .32	799 .24	837 .23	817 .20	781 .19	848 .19	796 .19	779 .17	798 .17	813 .17
FDR-05	949- 998	846 .49	813 .28	792 .25	779 .24	799 .22	796 .21	814 .20	837 .20	832 .19	781 .15	817 .15
FDR-05	951-1000	813 .27	792 .27	779 .25	796 .22	832 .21	837 .20	814 .20	799 .19	811 .15	794 .15	772 .15
FDR-06	946- 995	845 .44	839 .43	777 .29	824 .27	790 .25	804 .20	846 .19	807 .19	822 .16	780 .15	805 .12
FDR-06	951-1000	775 .32	839 .31	790 .28	812 .25	822 .24	824 .21	772 .21	780 .19	801 .19	788 .18	791 .18

CHART 3

PART 2: CORRELATIONS WITH MASTER SERIES OF ALL SEGMENTS AS DATED AND MEASURED Tucson-Mendoza-Hamburg-Lamont ProgLib

32-YEAR CUBIC SPLINE FILTER; CORRELATIONS OF 50-YEAR SEGMENTS LAGGED 5 YEARS

FLAGS: __A = CORRELATION UNDER 0.3281; __B = CORRELATION HIGHER AT OTHER POSITION

0SEQ	SERIES	INTERVAL	1775 1824	1780 1829	1785 1834	1790 1839	1795 1844	1800 1849	1805 1854	1810 1859	1815 1864	1820 1869	1825 1874	1830 1879	1835 1884	1840 1889	1845 1894	1850 1899	1855 1904	1860 1909	1865 1914	1870 1919	FLAGS/ TOTAL
1	FDR-01	1791-1847	=	=	=	.46	.44	.43	=	=	=	=	=	=	=	=							
+																							0/ 3
2	FDR-02	1795-1847	=	=	=	=	.52	.54	=	=	=	=	=	=	=	=							
+																							0/ 2
3	FDR-03	1805-1847	=	=	=	=	=	=	.60	=	=	=	=	=	=	=							
+																							0/ 1
4	FDR-04	1785-1846	=	=	.45	.49	.58	.59	=	=	=	=	=	=	=	=							
+																							0/ 4
5	FDR-05	1785-1846	=	=	.51	.57	.58	.59	=	=	=	=	=	=	=	=							
+																							0/ 4

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES Tucson-Mendoza-Hamburg-Lamont ProgLib

FDR-C VS FDR-01,02,03,04,05 DATED
50-YEAR SEGMENTS LAGGED 5 YEARS

SERIES	COUNTED SEGMENT	ADD CORR # 1	ADD CORR # 2	ADD CORR # 3	ADD CORR # 4	ADD CORR # 5	ADD CORR # 6	ADD CORR # 7	ADD CORR # 8	ADD CORR # 9	ADD CORR #10	ADD CORR #11
FDR-01	944- 993	847 .67	844 .28	848 .26	850 .20	851 .12	845 .09	852 .05	841 .03	849 .02	842 .00	853-.02
FDR-01	949- 998	847 .67	844 .29	848 .26	832 .18	849 .06	833 .06	841 .02	845 .02	842-.01	838-.05	831-.08
FDR-01	951-1000	847 .65	829 .29	844 .26	830 .17	832 .12	838 .05	842 .05	845 .04	833 .03	841-.07	831-.08
FDR-02	948- 997	847 .68	832 .29	850 .14	848 .12	844 .09	846 .08	841 .05	839 .02	843 .00	849-.02	838-.05
FDR-02	951-1000	847 .69	832 .25	829 .18	846 .11	844 .07	833 .01	831 .00	842-.02	843-.03	836-.03	839-.04
FDR-03	958-1000	847 .70	844 .36	825 .23	824 .22	828 .19	830 .15	833 .13	826 .09	823 .08	845 .08	846 .07
FDR-04	939- 988	846 .71	849 .27	843 .19	850 .16	852 .14	845 .13	848 .09	847 .08	853 .05	842-.07	855-.09
FDR-04	944- 993	846 .73	849 .27	843 .26	853 .14	850 .14	845 .09	852 .08	848 .00	837-.01	842-.02	847-.06
FDR-04	949- 998	846 .76	849 .26	843 .17	845 .14	831 .05	844 .04	848 .04	832 .03	834 .01	842-.01	847-.05
FDR-04	951-1000	846 .77	843 .21	830 .21	845 .10	844 .07	831 .04	832 .03	829 .02	834-.01	842-.04	847-.05
FDR-05	934- 983	846 .83	849 .24	864 .22	861 .13	863 .06	862 .05	855 .04	860 .04	850-.03	848-.03	851-.04
FDR-05	939- 988	846 .83	849 .23	842 .19	845 .15	844 .11	841 .10	843 .03	855 .02	848-.03	858-.05	851-.07
FDR-05	944- 993	846 .84	842 .20	849 .19	837 .16	843 .10	845 .07	848 .03	844 .03	840 .00	841-.01	839-.03
FDR-05	949- 998	846 .82	849 .19	845 .13	842 .13	837 .09	843 .07	839 .03	831 .02	848 .01	844 .01	841-.01
FDR-05	951-1000	846 .82	842 .12	845 .11	843 .10	837 .09	839 .07	830 .07	831 .02	844 .02	841 .01	847-.05
FDR-06	946- 995	845 .25	851 .17	847 .14	839 .11	836 .08	837 .06	840 .06	852 .06	849 .03	844-.02	842-.03
FDR-06	951-1000	845 .26	847 .20	831 .11	840 .10	842 .08	844 .04	829 .04	839 .01	846 .00	837-.01	841-.03

CHART 4

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES   Tucson-Mendoza-Hamburg-Lamont ProgLib

FDR-H VS FDR-08 UNDATED
50-YEAR SEGMENTS LAGGED 25 YEARS

SERIES	COUNTED SEGMENT	CORR ADD # 1	CORR ADD # 2	CORR ADD # 3	CORR ADD # 4	CORR ADD # 5	CORR ADD # 6	CORR ADD # 7	CORR ADD # 8	CORR ADD # 9	CORR ADD #10	CORR ADD #11
FDR-07	876- 925	0 .68	56 .45	32 .39	69 .25	36 .24	35 .23	75 .22	4 .21	5 .20	42 .19	30 .19
FDR-07	901- 950	0 .77	32 .30	6 .29	-24 .29	-22 .26	-25 .25	-26 .23	-38 .23	-32 .20	34 .18	24 .16
FDR-07	926- 975	0 .71	6 .42	-22 .31	20 .29	-51 .28	-56 .28	-26 .24	25 .22	24 .20	-14 .20	-32 .20
FDR-07	951-1000	0 .71	-22 .32	-57 .31	-25 .27	-78 .27	-20 .26	-2 .26	-82 .24	-81 .23	-76 .23	-13 .19
FDR-08	856- 905	01.00	25 .39	57 .38	56 .34	24 .32	82 .26	80 .22	27 .21	83 .21	58 .20	75 .19
FDR-08	881- 930	01.00	-25 .39	56 .34	-24 .34	58 .28	32 .28	2 .26	3 .22	-2 .21	57 .20	-1 .20
FDR-08	906- 955	01.00	-32 .29	32 .26	20 .22	26 .20	-30 .19	-38 .18	33 .17	-36 .16	14 .16	22 .16
FDR-08	931- 980	01.00	-56 .43	-57 .35	-32 .33	-14 .32	20 .31	-20 .27	12 .25	-34 .21	-26 .19	-75 .19
FDR-08	951-1000	01.00	-20 .31	-56 .31	-82 .29	-57 .27	-25 .27	-12 .26	-32 .23	-27 .22	-81 .20	-2 .20
FDR-09	866- 915	0 .81	56 .53	-1 .41	24 .31	82 .29	57 .29	26 .28	25 .27	31 .27	81 .25	-2 .19
FDR-09	891- 940	0 .85	32 .46	56 .35	-26 .35	-25 .31	-24 .29	-27 .27	-3 .24	57 .24	-1 .22	3 .22
FDR-09	916- 965	0 .89	20 .37	-57 .30	14 .29	32 .28	26 .24	-58 .23	-56 .23	-25 .23	-14 .22	12 .22
FDR-09	941- 990	0 .79	-20 .32	-22 .29	-82 .29	-33 .27	-57 .26	-46 .25	-32 .25	-2 .24	-34 .23	-44 .23
FDR-09	951-1000	0 .78	-57 .32	-22 .32	-20 .27	-76 .25	-82 .24	-81 .24	-25 .24	-78 .21	-2 .20	-56 .20
FDR-10	921- 970	-1 .59	-58 .43	-57 .39	-7 .39	25 .38	19 .33	-64 .31	11 .26	-33 .23	-15 .23	12 .20
FDR-10	946- 995	-1 .70	-83 .41	-26 .32	-57 .32	1 .29	-82 .29	-76 .26	-78 .25	-3 .23	-58 .22	-23 .20
FDR-10	951-1000	-1 .70	-83 .35	-26 .30	-57 .29	-3 .28	-82 .26	-76 .26	-23 .21	-28 .19	-58 .19	-84 .18

CHART 5

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES Tucson-Mendoza-Hamburg-Lamont ProgLib

FDR-H VS CRVM HEMLOCK MASTER
50-YEAR SEGMENTS LAGGED 25 YEARS

SERIES	COUNTED SEGMENT	ADD CORR # 1	ADD CORR # 2	ADD CORR # 3	ADD CORR # 4	ADD CORR # 5	ADD CORR # 6	ADD CORR # 7	ADD CORR # 8	ADD CORR # 9	ADD CORR #10	ADD CORR #11
FDR-07	876- 925	797 .37	844 .36	845 .35	877 .32	920 .31	850 .29	821 .29	906 .27	901 .26	820 .25	922 .24
FDR-07	901- 950	845 .36	901 .36	787 .33	820 .32	749 .31	801 .28	844 .26	903 .25	922 .25	765 .24	877 .23
FDR-07	926- 975	845 .58	851 .37	890 .32	763 .32	825 .31	751 .30	897 .29	864 .26	886 .26	819 .26	794 .22
FDR-07	951-1000	845 .47	825 .38	864 .29	764 .29	788 .27	719 .24	793 .23	808 .23	763 .22	706 .21	769 .21
FDR-08	856- 905	845 .59	800 .37	902 .36	901 .35	793 .28	876 .27	927 .26	957 .24	823 .24	869 .22	871 .22
FDR-08	881- 930	845 .54	903 .44	901 .37	844 .36	878 .31	795 .30	922 .30	820 .28	766 .28	877 .28	778 .24
FDR-08	906- 955	845 .64	901 .47	765 .34	844 .30	853 .29	766 .27	820 .26	787 .25	815 .23	819 .23	770 .22
FDR-08	931- 980	845 .72	788 .38	732 .34	890 .32	789 .29	825 .28	801 .27	847 .27	819 .25	793 .24	767 .23
FDR-08	951-1000	845 .57	825 .36	763 .34	866 .33	847 .30	820 .29	788 .28	732 .25	774 .24	793 .24	830 .24
FDR-09	866- 915	845 .62	844 .48	901 .45	876 .35	797 .31	800 .26	902 .26	823 .24	957 .21	857 .21	927 .20
FDR-09	891- 940	845 .56	820 .37	844 .36	901 .35	764 .24	881 .23	922 .23	850 .23	918 .22	877 .22	795 .21
FDR-09	916- 965	845 .63	732 .46	820 .38	787 .32	901 .31	859 .30	886 .28	867 .26	745 .26	806 .25	801 .24
FDR-09	941- 990	845 .49	825 .45	732 .44	767 .28	788 .28	847 .26	713 .26	801 .25	745 .25	857 .24	864 .24
FDR-09	951-1000	845 .48	825 .40	788 .33	763 .31	732 .29	745 .29	776 .25	847 .24	722 .24	793 .23	867 .23
FDR-10	921- 970	844 .57	787 .49	788 .35	896 .29	902 .27	800 .27	812 .26	819 .22	865 .22	778 .21	838 .21
FDR-10	946- 995	844 .71	846 .37	819 .28	737 .25	705 .24	865 .23	876 .23	743 .22	824 .22	762 .22	799 .22
FDR-10	951-1000	844 .68	819 .36	846 .36	799 .30	744 .27	758 .25	865 .25	705 .25	762 .24	742 .23	766 .22

CHART 6

PART 2: CORRELATIONS WITH MASTER SERIES OF ALL SEGMENTS AS DATED AND MEASURED Tucson-Mendoza-Hamburg-Lamont ProgLib

32-YEAR CUBIC SPLINE FILTER; CORRELATIONS OF 50-YEAR SEGMENTS LAGGED 25 YEARS

FLAGS: __A = CORRELATION UNDER 0.3281; __B = CORRELATION HIGHER AT OTHER POSITION

0SEQ	SERIES	INTERVAL	1700 1749	1725 1774	1750 1799	1775 1824	1800 1849	1825 1874	1850 1899	1875 1924	1900 1949	1925 1974	1950 1999	1975 2024	2000 2049	2025 2074	2050 2099	2075 2124	2100 2149	2125 2174	2150 2199	2175 2224	FLAGS/ TOTAL
1	FDR-07	1721-1845	.69	.69	.82	.81	.79	=															
+																							0/ 5
2	FDR-08	1711-1845	.79	.81	.83	.84	.82	=															
+																							0/ 5
3	FDR-09	1711-1845	.75	.79	.85	.89	.82	=															
+																							0/ 5
4	FDR-10	1765-1844	=	=	.65	.75	.74	=															
+																							0/ 3

PART 8: DATE ADJUSTMENT FOR BEST MATCHES FOR COUNTED OR UNKNOWN SERIES Tucson-Mendoza-Hamburg-Lamont ProgLib

FDR-H VS FDR-H SITE MASTER
50-YEAR SEGMENTS LAGGED 25 YEARS

SERIES	COUNTED SEGMENT	ADD	CORR # 1	ADD	CORR # 2	ADD	CORR # 3	ADD	CORR # 4	ADD	CORR # 5	ADD	CORR # 6	ADD	CORR # 7	ADD	CORR # 8	ADD	CORR # 9	ADD	CORR #10	ADD	CORR #11
FDR-07	876- 925	845	.86	901	.46	877	.33	902	.23	851	.23	850	.19	907	.18	881	.17	875	.17	878	.16	914	.16
FDR-07	901- 950	845	.92	821	.31	851	.30	813	.28	894	.27	877	.21	820	.21	816	.18	867	.17	869	.15	811	.15
FDR-07	926- 975	845	.90	851	.40	789	.39	794	.28	865	.27	823	.26	788	.24	819	.23	813	.21	852	.20	787	.19
FDR-07	951-1000	845	.89	789	.34	764	.31	823	.30	825	.29	788	.28	767	.27	832	.27	796	.23	843	.22	763	.21
FDR-08	856- 905	845	.94	870	.35	869	.34	902	.33	901	.30	927	.25	928	.23	871	.20	883	.20	920	.19	903	.18
FDR-08	881- 930	845	.91	901	.36	821	.29	820	.28	903	.22	842	.22	847	.22	843	.21	902	.21	846	.20	867	.20
FDR-08	906- 955	845	.91	813	.34	867	.25	859	.23	821	.22	815	.21	871	.20	809	.20	865	.19	816	.19	853	.18
FDR-08	931- 980	845	.92	789	.55	813	.35	788	.34	865	.29	770	.28	825	.26	839	.25	831	.24	833	.24	826	.20
FDR-08	951-1000	845	.90	789	.44	825	.33	764	.30	763	.26	820	.26	833	.24	832	.23	788	.22	813	.21	818	.21
FDR-09	866- 915	845	.90	901	.50	869	.34	844	.33	870	.30	871	.27	926	.27	927	.26	923	.26	902	.24	840	.21
FDR-09	891- 940	845	.92	877	.40	821	.35	901	.34	902	.26	870	.26	819	.25	820	.24	842	.21	899	.19	846	.18
FDR-09	916- 965	845	.96	789	.31	865	.31	859	.29	867	.28	788	.27	877	.25	813	.24	839	.23	821	.23	851	.22
FDR-09	941- 990	845	.92	825	.35	813	.30	788	.29	789	.28	763	.28	823	.25	838	,24	801	.24	812	.23	777	.22
FDR-09	951-1000	845	.91	789	.35	825	.31	788	.27	764	.27	823	.26	777	.24	796	.23	769	.23	756	.23	767	.20
FDR-10	921- 970	844	.77	788	.49	838	.44	787	.40	864	.32	870	.31	781	.30	814	.23	837	.21	812	.21	850	.20
FDR-10	946- 995	844	.86	788	.38	762	.34	767	.29	769	.28	763	.28	846	.28	838	.24	824	.23	819	.22	825	.21
FDR-10	951-1000	844	.85	788	.36	762	.27	763	.26	769	.25	819	.25	795	.25	801	.22	767	.21	824	.21	825	.21